The Importance of Studying the Actual Condition of Hospital Air

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THE IMPORTANCE OF STUDYING THE ACTUAL CONDITION OF HOSPITAL AIR*

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Few questions in air conditioning have been more extensively and even acrimoniously discussed in recent years than that of hospital ventilation. We hear on the one hand that costly ventilating plants have altogether failed and that the only way to keep a hospital in good condition is to abandon fan ventilation and admit fresh air by way of the windows. On the other hand, there are signs of a reaction in certain quarters against this view and we hear whispers that even in the most advanced window ventilated hospitals conditions are by no means always ideal, particularly at night and when the superintendent is not in the wards.

Architects and engineers, to say nothing of hospital trustees, find themselves buffeted about in a most confusing manner between confident and contradictory disputants. Ventilating plants which cost many thousands of dollars are lying idle and new hospitals are being built without any artificial ventilation at all, which, if the advocates of fan ventilation should prove correct, means a far greater expenditure for the installation of some system of air conditioning in the future.

The extraordinary thing about it all to the sanitarian is that these sweeping conclusions and far-reaching changes in policy have as a rule been arrived at without any detailed and systematic study such as seems essential in order to establish a safe basis for action. No good physician would to-day diagnose a difficult case by glancing at the patient, without taking his pulse or using the modern methods of clinical diag-

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nosis. Yet hospital superintendents condemn their ventilating plants because a room seems stuffy, without accurate observation of existing conditions, or study of the possible remedies which might be applied, short of a major operation.

The sling psychrometer and the anemometer are as essential to the student of ventilation as are the clinical thermometer and blood tests to the practicing physician. It has been clearly shown by the elaborate experiments of some of the most eminent physiologists in Germany, England and the United States that the discomfort and the physiologic disturbance experienced in a badly ventilated room are primarily due not to chemical impurities in the air but to heat and humidity—not to respiratory phenomena, but to derangements of the vasomotor mechanism. It is therefore a first essential in studying air conditions to make careful records of temperature and humidity at various points and at various times under various conditions of occupancy. Air conditioning is, however, intimately bound up with air change and air movement, and the removal of stale odors is eminently desirable from an esthetic standpoint even if the organic compounds which produce them do not menace health. Carbon dioxid tests are therefore also of great value in determining accurately the amount of air change which is taking place, and under special conditions may well be supplemented by determinations of atmospheric dust and perhaps sometimes of bacteria.

If tests of the sort outlined above show that the air is clean and fresh and of a cool, equable temperature, one may rest satisfied. If, on the other hand, air conditions prove to be unsatisfactory, it is neither reasonable nor scientific to condemn the system in use, whether it be fan ventilation or window ventilation, without a further effort to find out the exact reason for the trouble. If rooms are overheated it may be because hand-controlled radiators have been left turned on or because thermostatic control valves have been allowed to get out of order. Or it may be because the janitor is overheating a plenum air supply. In one New York school an inspector working under my direction had a thermometer registering to 130 F. exploded by the heat of the air entering a room register. If there is too much carbon dioxid and a stuffy

odor in a room, it may be because the ducts are insufficient or because the inlets and outlets are wrongly placed, or because the fans or motors are not being operated at their full capacity. Sometimes the trouble is practically irremediable without costly construction. Sometimes it can be eliminated at no cost at all with the application of a little technical skill in operation. It would seem in general wise before either installing or discarding a ventilating system to obtain scientific data as to the exact shortcomings which exist and the extent to which they could be remedied by minor alterations or more intelligent operation.

Prof. Charles Baskerville and I carried out a study of schoolroom ventilation in New York City in which our staff made over 1,800 observations of temperature and humidity, over 770 of carbon dioxid, over 680 counts of microbes and over 650 counts of dust particles, in addition to many hundreds of special tests of air distribution and a large number of measurements of air velocities. The result of this study was to show in the first place that the hectic accounts of New York schoolroom air which had been spread broadcast were, as Mark Twain said of his own premature obituary, "grossly exaggerated." Only 14 per cent. of the 1,854 temperature records obtained were over 71 F., and only 5 per cent. over 73. Of 773 carbon dioxid determinations, only 15 per cent. were over 10.5 parts and 6 per cent. over 12.5 parts. The average results for all fan-ventilated schools were about the same as for all window-ventilated schools, but individual schools showed marked deviations from the normal. The window-ventilated schools were all mediocre, but some of the fan-ventilated schools were admirable and some very poor, not apparently as a result of defective construction, but mainly from careless operation. In one school an automatic thermograph kept in operation for twenty days never but once fell below 60 F. and never rose as high as 70. In another school, fan-ventilated like the first, the temperature reached 75 on eighteen out of twenty-eight days, and reached 80 on six of them. Only by a detailed and exact study was it possible in the first place to clear the air conditions of the New York schools in general from unfair aspersions, and in the second place, to find out that in certain particular schools there were evils to be remedied, and in the

third place to indicate the importance of janitorial supervision in remedying those evils.

I am at present conducting a somewhat similar study of air conditions in a commercial establishment employing about 4,000 clerks, in the course of which my inspectors have made 2,185 temperature and humidity records, 245 carbon dioxid determinations and over 300 measurements of air velocity. The results are not yet fully analyzed, but they have already shown clearly that the building is grossly overheated and that the fault lies in large part with the disrepair into which the thermostats have been allowed to fall. We are finding that in certain ducts designed for fan ventilation, no fans have ever been installed, while in others the fans are running at only a fraction of their efficient speed. In other ducts the register openings are so badly adjusted to the present population that while some rooms receive more air than they need, others receive much less. It is quite possible that somewhat radical improvements in ventilating construction may have to be made in this building, but it would be most unwise to undertake such improvements without first finding out what the present plant is actually doing and what it could be made to do with the best operation.

I cite these cases merely to show the method of approach to this scientific problem of air conditioning and to contrast what has been done by school authorities and industrialists with the scanty evidence on which hospital ventilating plants have been defended or condemned.

Two years ago I suggested to Miss Alice L. Lake, a graduate student of mine in the Department of Nursing and Health of Teachers' College, that she attempt to gain some idea of what air conditions in New York hospitals actually were. The results[1] are distinctly significant and, like the school results cited above, point to the factor of operation as one of prime significance. Miss Lake obtained seventy-five records of temperature and humidity in six different hospitals. The general wards in all the hospitals but one were free from overheating, forty-three records out of fifty-two being below 70 F. Two hospitals in particular showed all temperatures closely controlled between 60

1. Lake, Alice L.: Journal of Home Economics, October, 1913.

and 69, and it is worthy of note that of these two good hospitals, one is ventilated on the plenum system and the other by windows. On the other hand, there is one hospital in New York which is notorious for its overheating, and here Miss Lake obtained three records between 70 and 74, and two of 75 and over.

The overheating of the children's wards was much more marked, five out of eleven records being over 70 F. In one hospital the children's ward was 76 in the daytime and 57 at night, which seems a needlessly violent contrast.

The air of all the hospitals was very dry, irrespective of the method of ventilation, sixty-three out of seventy-five records being below 40 per cent. of saturation. In the operating rooms the temperature of course was very high (in six cases out of twelve, over 74 F.) and the humidity correspondingly low (in five out of twelve cases, 30 per cent. or below, in none over 40 per cent.). It seems to me a serious question whether such very dry air may not promote harmful evaporation from the exposed body cavity. Artificial humidification would not only lessen evaporation but would diminish the cooling effect and so make it possible to avoid the extremely high temperatures now generally considered necessary.

My aim in presenting this paper is merely to call attention to the fact that there are serious problems involved in hospital air conditioning and that there are recognized scientific methods of attacking such problems which have so far very rarely been applied. Physiologic studies have shown that air temperature and air humidity have profound effects on the human organism, and in hospitals, in which you are dealing with persons of subnormal vitality, these effects must be intensified. In schools and factories serious attempts have been made to find out what air conditions are being maintained and how they can be improved. In many hospitals the operation of the ventilating plant is left in unskilled hands with no supervision, until bad conditions force themselves on the senses, and then the whole system in force is discarded without an attempt to find out what is really wrong.

Is it not time that this problem should be recognized as one demanding the serious scientific study of those responsible for hospital control? In an institu-

tion devoted to healing, the atmospheric condition surrounding the patients is clearly one of the most important environmental variables involved. It should not be controlled by snap judgment or by the dogmas of a fan-ventilation cult or a window-ventilation cult. The particular hospital and the particular ward should be studied and its trouble diagnosed as you study your patients to diagnose their diseases. Automatic thermographs should be installed at typical locations and their hourly records watched by some one in authority, and supplemented by occasional observations with the sling psychrometer. Once a year or so a test should be made of the whole plan with carbon dioxid determinations and anemometer measurements to see if windows or ducts are supplying a requisite amount of air. Thermostats should be overhauled and fans rated and duct velocities measured. Only by such studies can it be determined whether fan ventilation or window ventilation is efficient in a given case, and if not, how results can be improved. Only by such studies can the best future policy in building new hospitals be wisely and safely determined.